Loading Arm Replacement Project Lessons Learned

Bipin Sitaram, Anna Tsai
Project Managers – Execution

Karen Boven
Project Manager - FEED

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Loading Arm Replacement Project
Lessons Learned

Original Arms

Replacement Arm Design and Fabrication
  • Factory Inspection / QC

Transportation

Construction
  • Removal of Existing Arms
  • Replacement Arm Installation
  • Hydraulics and PLC Controls

Operability Improvements

Acknowledgments
Existing Loading Arms - DCMAs

- **Wharf Overview**
  - Largest marine oil terminal on west coast
  - Import refinery crude and feedstocks
  - Export products
  - Constructed in 1940s
  - Modernized in 1970s/1990s
  - Dated berthing configuration

- **Marine Loading Arm (MLA) History**
  - Double counterweight marine loading arms (DCMA)
  - Installed in 1973
  - Refurbished from other facility
  - 66% Availability (Berth 1 and 4)
  - Obsolete design
New Loading Arms – Design Drivers

1. Structural Loading
   To avoid additional pile driving, CVX used existing loading arm foundations.
   Decision: Selected Rotating Counterweight Marine Arms (RCMAs) instead of Double Counterweight Marine Arms (DCMAs) to reduce equipment weight.

2. Current velocity < 1.5 kt
   Decision: No Emergency Release Couplings (ERCs) required, which would have dramatically increased the structural pile driving necessary at each berth due to their weight.

3. Manufacturer selection
   Chevron competitively bid loading arms with 3 different manufacturers.
   Decision: Went with same manufacturer of existing arms.

4. Fabrication / Installation Schedule
   Timing of planned Berth 4 shutdown (45 days, 4Q2016) drove phased production of loading arms by berth, enabling Chevron to incorporate lessons learned into the arm design, transport and installation at the subsequent berths.

5. MOTEMS compliant for sea level rise accommodation (16” by 2050)
Replacement Arm Design and Fabrication

Lessons Learned

Design

Use existing foundations
- RCMA weighs less than DCMA
RCMA has greater operating envelope
- Can accommodate more modern vessels
RCMA needs greater footprint to operate
- Structural extension of Berth 3 (3 ft.)
- Addition of Berth 1 drip pan

Quality

Location of nozzles on RCMA
- Not true low point → up to 2 gallons of product
- Miss-alignment of inboard arm outlet nozzle
  - Result: Additional verification of critical dimensions by 3rd party inspector
Bolt pattern on cover plate interfered with ring seal
Inconsistent supplier torque values & torque procedures
- Leaky joints and loose fittings
  - Result: Retorqued joints prior to installation
Supplier did not follow their own QC procedure
  - Result: Hired 2 additional Quality Engineers to support project

Additional Inspection

Retained expediter for B4 RCMA to keep schedule
100% vs 20% x-ray of full penetration welds
- Paid premium to supplier to prioritize inspection to meet schedule
- City of Richmond weld inspector onsite to inspect structural welds
- Supplier became CoR approval fabricator for this job only.
Positive Material Identification (PMI)
Transportation
Schedule-driven choices and lessons learned

Needed 6 week (max) transit from Europe to USWC:
- Truck from Sens, France ➔ Zeebrugge, Belgium
- Shipping: Zeebrugge ➔ Pt. Hueneme using Ro/Ro
- Truck from Pt. Hueneme ➔ Alameda
- Barge from Alameda ➔ RLW by barge

Five (5) lifts per arm.

Lessons learned as a result of Berth 4:
- Contract logistics coordinator with international experience
- Marine surveyor (inspector)
- Reinforced crating with double cross braces
- Shock watch
- Tie-down strap angles verified for trucking
- Additional padding/carpet at points of contact.
Transportation
Schedule-driven choices and lessons learned

Transferring to a trailer at Zeebrugge.

On material barge in Alameda awaiting installation at RLW.
Transportation
Schedule-driven choices and lessons learned

Chevron Delivery of Berth 4 Arms

RCMA 2
The arm showed up with the pentagraph sitting on the wood blocking below indicating that the crate shifted forward during transit. After un-crating, no damage to the pentagraph was observed.

Crate shifted forward

Pentagraph cut into the wooden crate

Chevron Delivery of Berth 4 Arms

RCMA 5
Crate failed moving laterally.

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Phased Approach – Berth 4, then 3 and 1.

Pre-Shutdown Work
– Structural
– Removed OOS DCMAs
– Rerouting of utility lines

Berth 4 – 45/60 day shutdown
– Continuous window enabled troubleshooting.
– 4 arms removed during shutdown.
– Structural work done before shutdowns began.

Berth 3 and 1 – Done in parallel
– 3-5 day natural window outages vs. 10 day planned shutdowns
– 2 arms removed at a time, 2 arms set in position.
– Compressed schedule
– Friday / Saturday work as needed.
– Electrical / tubing work completed as SimOps.
– Mobile hydraulic oil pre-filter/testing lab on site
– Arm installation timeframe reduced by 3 days per arm.
Construction

General
General contractor attended training and FAT at supplier
Non-Shutdown work at various berths are worked in parallel to
• Minimize down time or demobilization from RLW
• Maintain dedicated crew
Phase approach to allow incorporation of lessons learned from Berth 4 into Berth 3 and 1

Base riser lift at Berth 4
Removal and Installation of MLAs

B4 has dedicated continuous outage window (45 Days Planned vs 60 Days Actual)
- OOS DCMA was removed during pre-work
- Temp support of operating platform

B1 and B3 are in operation during construction
- Use “natural windows” to remove DCMA during pre-work
- Working Fridays and/or Saturdays as needed
- SimOps: electrical and tubing work
- Each outage is planned for removal and installation 2 MLAs

MLAs needs to be pre-balance before installation

Lifting and setting outboard arm – Berth 4
New Hydraulic System Design
• Isolated hydraulic circuit (CVX design) to minimize down time during repair
• Two layers of protection to prevent operating arm by mistake

Lessons Learned
• LOTO MLAs that are not in operation
• Mobile hydraulic lab to clean hydraulic oil to NAS class 9
• Biodegradable hydraulic fluid
  – Shipped to loading arm supplier for Factory Acceptance Test
Construction – Controls

New Control System
- Remote Controlled (preferred)
- Local Control Panel (LCP)
- Selector Valve Assembly (SVA)

Lessons Learned
- Added universal remote (3 Berths)
- Miscommunication between supplier and sub-vendor caused frequent drop of radio signal
- Supplier did not test out all functionality of remote controller
- Added additional test functions on LCP
Operability Improvements

Improved Efficiency Beyond Expectations
45 minute connection time reduced to 7 minutes.
Less reliance on ships crew for connection validation.

Operator
One operator needed (on board vessel) for connections; no longer requires two operators.

Safety
No wrenching or crow bars required for connections.
Improved Safety in Designs (SID).

Predictability
Consistent slewing distance (8.4 feet) per arm.
Berth 4

Before

After
Accomplishments

- 18 critical lifts over water
- Installed and commissioned Berth 4 MLAs (4 total) in 4Q16
- 87k+ Safe Construction Hours
- Ahead of schedule - Optimized installation of MLA by advancing schedule
- Within Budget - Potential $3MM saving in construction cost and overall capital budget
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